What is claimed is:

1.A semiconductor device comprising a $B_{1-x-y-z}In_xAl_yGa_zN(0 \leqq x \leqq 1, 0 \leqq y \leqq 1, 0 \leqq z \leqq 1)$ alloy epitaxial film having 4H-polytype structure formed on a substrate having 4H-type structure.

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2. The semiconductor device according to claim 1, wherein the substrate is silicon carbide.

3.The semiconductor device according to claim 1, wherein said $B_{1-x-y-z}In_xAl_yGa_zN$ $(0 \leqq x \leqq 1, 0 \leqq y \leqq 1, 0 \leqq z \leqq 1)$ alloy epitaxial film is formed on a substrate having (11-20) face.

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4.The semiconductor device according to claim 1, wherein said $B_{1-x-y-z}In_xAl_yGa_zN$ $(0 \leqq x \leqq 1, 0 \leqq y \leqq 1, 0 \leqq z \leqq 1)$ alloy epitaxial film comprises AlN.

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5.The semiconductor device according to claim 1, wherein a number of group III atoms are equal to a number of nitrogen atoms on a surface of said $B_{1-x-y-z}In_xAl_yGa_zN(0 \leqq x \leqq 1, 0 \leqq y \leqq 1, 0 \leqq z \leqq 1)$ alloy epitaxial film.

6. An optoelectronic device comprising,

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a GaN-based epitaxial layers having 4H-polytype structure formed over a substrate having 4-H type and a waveguide formed on said GaN-based epitaxial layers having 4H-polytype, and

wherein said GaN-based epitaxial layers having 4H-polytype structure include an n-type layer, a p-type layer and an active layer, said active layer being formed between said n-type layer and said p-type layer.

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7. The optoelectronic device according to claim 6, wherein a plurality of layers being formed between said waveguide and said substrate have 4H-type structure.

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8. The optoelectronic device according to claim 6, wherein said substrate having 4-H type structure is SiC.

9.The optoelectonic device according to claim 6, wherein said GaN-based alloy epitaxial film is formed on a substrate having (11-20) face.

5 10.The optoelectonic device according to claim 6, wherein said GaN-based alloy epitaxial film comprises AlN.

11.The optoelectonic device according to claim 6, wherein a number of group III atoms are equal to a number of nitrogen atoms on a surface of said GaN-based alloy epitaxial 10 film.

12. The optoelectronic device according to claim 6, wherein said waveguide is formed as a straight line perpendicular to either (0001) face or (1-100) face.

15 13. The optoelectronic device according to claim 6, further comprising AlN layer having 4H type structure between said GaN-based epitaxial layers having 4H-polytype structure and said substrate having 4-H type structure.

14.The optoelectronic device according to claim 13, further comprising an n-type 20 region formed in said GaN-based epitaxial layers having 4H-polytype structure and in contact with said AlN layer having 4H type structure.

15. The optoelectronic device according to claim 13, further comprising no epitaxial region is contact with a side surface of said AlN layer having 4H type structure.

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16. The optoelectronic device according to claim 6, further comprising conductive AlGaN layer having 4H type structure between said GaN-based epitaxial layers having 4H-polytype structure and said substrate having 4-H type structure.

30 17. The optoelectronic device according to claim 6, where said substrate having 4-H type structure exhibits p-type conduction.

18. The optoelectronic device according to claim 6, further comprising a first contact is formed on said waveguide and a second contact is formed under said substrate having 4-H type structure.

5 19. The optoelectronic device according to claim 18, wherein the first contact and the second contact includes Ni.

20. The optoelectronic device according to claim 18, wherein the first contact includes Ti and the second contact includes Al.

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21. A semiconductor device comprising,

GaN-based epitaxial layers having 4H-polytype structure formed over a substrate having 4-H type structure and an electrode formed over said GaN-based epitaxial layers having 4H-polytype structure, and

15 wherein said GaN-based epitaxial layers having 4H-polytype structure include an n-type layer, a p-type layer.

22. The semiconductor device according to claim 21, wherein a plurality of layers being formed between said electrode and said substrate have 4H-type structure.

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23. The semiconductor device according to claim 21, wherein said substrate having 4-H type structure is SiC.

24.The semiconductor device according to claim 21, wherein said GaN-based alloy

25 epitaxial film is formed on a substrate having (11-20) face.

25.The optoelectonic device according to claim 21, wherein said GaN-based alloy epitaxial film comprises AlN.

30 26.The optoelectonic device according to claim 21, wherein a number of group III atoms are equal to a number of nitrogen atoms on a surface of said GaN-based alloy epitaxial film.

27. The optoelectronic device according to claim 21, further comprising AlN layer having 4H type structure between said GaN-based epitaxial layers having 4H-polytype structure and said substrate having 4-H type structure.

5 28. The optoelectronic device according to claim 21, further comprising conductive AlGaN layer having 4H type structure between said GaN-based epitaxial layers having 4H-polytype structure and said substrate having 4-H type structure.

29. The semiconductor device according to claim 21, where said substrate having 4-H
10 type structure exhibits p-type or n-type conduction.

30. A semiconductor device comprising,

GaN-based epitaxial layers having 4H-polytype structure formed over a substrate having 4-H type structure, and a gate electrode, a source electrode and a drain electrode
15 formed on said GaN-based epitaxial layers having 4H-polytype structure, and

wherein said GaN-based epitaxial layers having 4H-polytype structure include an conductive layer, an undoped layer.

31. The semiconductor device according to claim 30, wherein a plurality of layers
20 being formed between said gate electrode and said substrate have 4H-type structure.

32. The semiconductor device according to claim 30, wherein said substrate having 4-H type structure is SiC.

25 33.The semiconductor device according to claim 30, wherein said GaN-based alloy epitaxial film is formed on a substrate having (11-20) face.

34.The optoelectonic device according to claim 30, wherein said GaN-based alloy epitaxial film comprises AlN.

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35.The optoelectonic device according to claim 30, wherein a number of group III atoms are equal to a number of nitrogen atoms on a surface of said GaN-based alloy epitaxial film.

36. The optoelectronic device according to claim 30, further comprising AlN layer having 4H type structure between said GaN-based epitaxial layers having 4H-polytype structure and said substrate having 4-H type structure.

5 37. The semiconductor device according to claim 30, wherein said AlN layer having 4H type structure includes an undoped layer and said undoped layer in contact with said GaN-based epitaxial layers having 4H-polytype structure.

38. The semiconductor device according to claim 30, wherein said n-type layer is
10 contacted to said gate electrode, said source electrode and said drain electrode.

39. The semiconductor device according to claim 30, where said GaN-based epitaxial layers having 4H-polytype structure have a modulation-doped structure.

15 40. A method of forming a semiconductor device comprising,

forming GaN-based epitaxial layers having 4H-polytype structure on a substrate having 4H-type structure.

41. The method of a semiconductor device according to claim 40, wherein at least a
20 part of said GaN-based epitaxial layers having 4H-polytype structure is grown by metal organic chemical vapor deposition or molecular beam epitaxy.

42. The method of a semiconductor device according to claim 40, wherein a first layer of said GaN-based epitaxial layers having 4H-polytype structure is grown by molecular beam
25 epitaxy and a second layer of said GaN-based epitaxial layers having 4H-polytype structure is grown by metal organic chemical vapor deposition.

43. The method of a semiconductor device according to claim 40, wherein said GaN-based epitaxial layers having 4H-polytype structure are formed over 1000°C.

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44. The method of a semiconductor device according to claim 40, wherein said GaN-based epitaxial layers comprises an AlN layer having 4H type structure as an initial layer and said AlN layer is grown by molecular beam epitaxy.

45. The method of a semiconductor device according to claim 40, wherein said substrate having 4-H type structure is treated in HCl acid, aqua regia and HF acid before said forming said GaN-based epitaxial layers having 4H-polytype structure.

5 46. The method of a semiconductor device according to claim 40, further comprising forming a waveguide on said GaN-based epitaxial layers having 4H-polytype structure.

47. The method of a semiconductor device according to claim 46, said waveguide and said GaN-based epitaxial layers having 4H-polytype structure are cleaved along to <0001> or
10 <1-100> direction.

48. The method of a semiconductor device according to claim 40, further comprising etching a buffer layer selectively and forming a seed layer in contact with said buffer layer before forming said GaN-based epitaxial layers having 4H-polytype structure on said buffer
15 layer, and

wherein said seed layer is formed in said GaN-based epitaxial layers having 4H-polytype structure.

49. The method of a semiconductor device according to claim 48, wherein a surface of
20 said substrate having 4-H type structure is exposed after said etching.